The Real World of Human Factors:

Where are we, and where are we going?[1]

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Good morning—it is a real pleasure to be here with all of you in beautiful Semi-Ah-Moo! I look forward to the next couple of days—based on past experience, this is a meeting well worthwhile.

Let me start by thanking Bob Hilb, Bob Buley, and Will Russell for organizing this morning's panel. And while I'm at it, let me note for the record that all of us owe a great debt of gratitude to Bob Buley and Will Russell for their outstanding efforts to promote the advancement of human factors within the airline community. Their efforts, under the aegis of the ATA Human Factors Task Force, have been instrumental in providing a broad blueprint for needed human factors efforts as embodied in the National Plan for Human Factors, and in securing needed support from both government and industry organizations. They have done an impressive job—thanks Bob and Will, and thanks to all of you for supporting their efforts.

The topic for our panel today is the real world of human factors, a topic that not too many years ago many of your predecessors might have said is an oxymoron. I will never forget a comment made by Hart Langer's predecessor (several times removed), Bill Dunkle, about his views of NASA scientists in general, and human factors specialists in particular. "Human factors scientists," Dunkle said, "always seem to me to be a bunch of people wearing white coats, seated around a big table, holding hands, and trying to establish contact with the living!" And lest you get the wrong impression, let me add quickly that Bill Dunkle was an extremely important, early proponent and supporter of human factors efforts to improve aviation safety—without his early support, the NASA program might well have gone nowhere

But Dunkle's point was a good one, then and fortunately to a much lesser extent, now. All too often, human factors specialists have not been good at establishing effective contact with the living, and for this reason, their work has often had little significant impact upon the real world. Too often, there has been, and continues to be, a genuine disconnect between the profession and those people, like yourselves, who need practical, effective, and timely solutions to problems. The purpose of this panel, as I understand it is to step back and take a look at where human factors stands, including a look at some of the successes, and a look at some of the areas where we need to redouble our efforts. As always, your support for this work is absolutely critical—without you there is no customer, no consumer, and therefore, no market.

I thought it might be useful to start at the beginning—with a definition of "human factors." Unfortunately, the term has come to have many meanings, especially in the popular press. One of my favorite examples of this occurred a couple of years ago in New York City where I accompanied the "go-team" to conduct an investigation of a fatal subway accident. As frequently happens in these situations, one of the local papers, a classic New York tabloid, did a "human interest" story on the investigative team, including Board Member John Lauber. Although I tried carefully during the interview to define what human factors is all about, the headline the next day told the story, "NTSB Team Headed by Doctor of Human Tragedy." When I got started in this business, I didn't realize just what I was getting into!

Let me start with what human factors is NOT. It is not clinical psychology; it is not counseling psychology, it is not hand-holding, let's-be-warm-and-fuzzy-hot tub stuff (although I personally have nothing against hot tubs or warm and fuzzy stuff). Human factors people do a lot of analysis, but they don't "analyze people" if you get my drift.

[1] Remarks presented at Air Transport Association of America Operations Forum, Semi-Ah-Moo, WA, September 19, 1994

Human factor IS an eclectic combination of engineering, experimental psychology, neuroscience, computer science, and ergonomics—literally, "the science of work." It is the application of scientific methodology and principles to the study, design, maintenance, and operation of complex man-machine systems. Human factors focuses upon individuals, teams, and organizations; and upon controls, displays, and tasks. The primary objective of human factors engineering is to optimize the performance of systems by adapting humans to the machines, for example, through training, and by adapting the machines to the humans, for example, through the application of such design principles as "control-display compatibility." Human factors is, in short, a central, critical component of systems engineering.

Let's take a quick look at where we've come in aviation human factors. One of the best examples of how human factors research can contribute to the solution of real-world problems is CRM—Crew Resource Management—the notion that flying a modern aircraft involves considerably more than simple stick-and-rudder skills. Decision-making, communications, and good leadership and followership skills are just as important to the safe and efficient operation of your aircraft as are the highly tuned manual control skills traditionally associated with being a pilot. It is now difficult to go anywhere in the world and find no indication of at least some understanding or appreciation of the importance of good CRM. The concept is being applied in diverse organizations around the globe, although I must say, still with widely varying degrees of efficacy and success. Nevertheless, it is clear that the concept has had a major impact upon the way we train airline pilots everywhere. It's an area that several of us here, including Clay and myself, have had a long association with, and I know that I can speak for both of us when I say that we are very proud of what has been accomplished in this area

Another comparative human factors success story can be found in the NASA fatigue countermeasures program There is an entire panel devoted to this topic later on this program, so I won't dwell on it here, but it is another example of how real-world oriented, scientifically sound human factors research can make a genuine contribution to safety and efficiency in aircraft operations.

While recounting where we have come in this area, let me also note that, compared to a decade or two ago, the operational community is much more highly aware of the importance of human factors problems and solutions. Note, for example, that it is difficult to pick up any trade publication, aviation safety journal, or other aviation-oriented publication without finding frequent reference to human factors issues in the aviation world. I take it as a special tribute to the human factors community that this panel comes first in your busy program, and that two other scheduled panels are also focused on human factors issues Again, it is difficult to go anywhere in the operational world and not find some example illustrating the fact that as a community, the aviation industry is now much more knowledgeable about human factors problems, and solutions, than previously. ICAO has implemented requirements for pilot licensing that include a human factors educational component. Accident investigation authorities now nearly universally apply some form of human factors inquiry in their conduct of official accident investigations, including examination of individual, team, and corporate cultural factors as they might be related to individual accidents. All the major airframe manufacturers employ human factors practitioners in various stages of the design process, again with varying degrees of success. Government regulatory authorities likewise now display significant appreciation for the role of human factors in the aviation system. In short, I think we can safely say to Bill Dunkle that the human factors community has, in fact, been successful in establishing contact with the living. The challenge now is to keep that line of communication open.

That's the good news But, can we just pack it up and go home? I think not, and here are a couple of thoughts about what else we as a community must do in the human factors arena—and I know each of the other panelists also intend to offer their views on this question of where do we go from here. Between the several of us, we ought to generate a fairly comprehensive set of concerns.

Let me start by talking about the role of human factors in design, although I know that Curt and Kathy also will address this area. It is clear, based on a history of recent incidents and accidents that we have not yet hit upon an optimal approach to the design of the interface between flight crew and highly automated aircraft The accident at Nagoya, the incident at Hong Kong, and previous accidents involving highly automated aircraft all raise some unsettling questions. And although these events have largely involved aircraft from one manufacturer, it is not wise to assume that the underlying problems don't exist

elsewhere—I doubt that any manufacturers' aircraft are completely free of potential for human error incidents and/or accidents; i.e., they have, inherent in their design, what Professor James Reason calls, latent failures: pathogenic bugs that will only become manifest under the "right" set of conditions, sometimes with only embarrassing consequences, and sometimes with tragic ones. What this says to me is that human factors considerations are still not sufficiently integrated into the design process; it's not that manufacturers are producing *bad* designs, but they are not optimal designs, and they can, on occasion, trap the unwary (and sometimes even the wary). I think what is required is a more systematic, formal approach that incorporates human factors expertise not only in the preliminary and initial design stages of a product cycle, but throughout that product's service life, making use of information learned from in-service experience for appropriate design modifications, when appropriate, but probably more importantly, using such feedback from line service to other elements of the system, most importantly, procedure development, and training and educational programs. In short, ultimate solution of human factors related design issues is dependent upon the application of a true systems approach. Clearly, one implication of this is that a formal, open line of communications between you, the maintainers and operators, and the manufacturers is of vital importance.

Another area of concern that I have is, unfortunately, and unintentionally, implicit in the discussion just completed: at this stage in the development and application of real-world human factors programs, the focus has been largely on the cockpit. It is a fact that many of our pressing problems have their origin well beyond the cockpit door. For example, there is increasing recognition of and attention to the problem of achieving effective integration of cockpit and cabin crews. There are some laudable efforts underway that apply CRM training and operating principles to cabin crew; similar comments can be made for dispatchers and maintenance personnel. I am a proponent of such efforts to extend the concept of *crew* resource management to the other legitimate members of the crew; I think the record clearly indicates that such efforts are worthwhile.

But in addition to the application of CRM principles to maintenance crew as well, I think one of the areas of highest potential payoff to you, both in terms of safety and economic benefits, is in attending to the fundamental human factors of aircraft and systems maintenance. David Marx, under Curt Graeber's direction at Boeing, has done some outstanding work in this area, and has some good quantitative data illustrating the magnitude of the problem (and thereby, the magnitude of the potential rewards). They have shown, for example, that a significant number of in-flight turnbacks are directly attributable to maintenance error. The very same principles of human error management and containment that apply to the cockpit apply to shop and line maintenance operations. And the very same fundamental solution—through the application of a true systems approach to the design, manufacture, and in-service operation of aircraft—apply in this area too.

Very similar comments can be made in one other area that also has direct, bottom-line impact on aviation safety and economics, air traffic control. Again, there are efforts underway to apply such concepts as CRM to the air traffic control suite; these seem to be promising. But also again, fundamental human factors issues ranging from selection and training, to task and equipment design, have not been adequately addressed at this time. Although outside your direct control, it seems clear to me that you have a vital interest in seeing that these issues are effectively treated, and the sooner the better.

Let me close on another point that I want you to consider. I mentioned at the outset of my remarks the National Plan for Human Factors, developed by Clay Foushee during his stay at the FAA using the broad blueprint provided by the ATA Human Factors Task Force. Although Clay did a tremendous job in overseeing the preliminary development and deployment of the plan, his departure left a hole that has never been filled. I can't in good conscience dance around the issue—I believe the National Plan for Human Factors is withering on the vine and has a good chance of dying unless there is a concerted effort to resurrect it by you and others who are the ultimate customers for its products. NASA-Ames, the institutional home of much of the research, and now, apparently, FAA's RE & D effort are undergoing major reorganizations, thus compounding the danger, at least in the short term. The program needs support, and most importantly, leadership, to reverse the entropic dissolution of what once was a highly promising start. This is only likely to happen with your direct support and efforts. The Administrators of both the FAA and NASA need to hear directly from you, the consumer of their primary products, that you

support the efforts of both agencies in this vital area. Congressional leaders need to know of this support as well. And I urge you to continue your support for these activities through the committee structure of your trade association; that of course, includes providing adequate resources—people—to make the system work Such activities are vital if we are, as an industry, ever going to greatly diminish the proportion of accidents due to human error. If we don't succeed in this, we are dooming ourselves to repeat the sad experiences of those who have gone before, and stand in danger of loosing the established lines of communication with the living.

Thanks again, and I look forward to hearing your views on this matter